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WATER SUPPLY AND WATER QUALITY CONTROL STUDY, LITTLE BLUE RIVER BASIN, MISSOURI

Federal Water Pollution Control Administration
Kansas City, Missouri

March 1966

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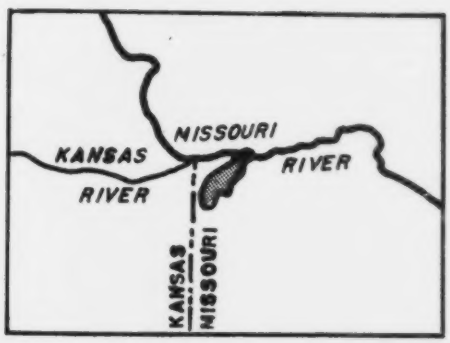
WATER SUPPLY AND WATER QUALITY CONTROL STUDY LITTLE BLUE RIVER BASIN MISSOURI

Study of the Needs and Value of Storage for Municipal and Industrial Water Supply and Water Quality Control



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WATER SUPPLY AND

WATER QUALITY CONTROL STUDY

LITTLE BLUE RIVER BASIN

MISSOURI

ABSTRACT

A survey has been made which discloses no need for storage for municipal and industrial water supplies and an immediate need for storage for streamflow regulation for the purpose of water quality control. These conclusions are based on results of engineering, economic and demographic studies. Future needs are based on projected population and industrial growth.

Prepared for

DEPARTMENT OF THE ARMY

U. S. Army Engineer District

Kansas City, Missouri

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

Federal Water Pollution Control Administration

Kansas City, Missouri

March 1966

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I. INTRODUCTION

Request and Authority

In a letter dated September 18, 1964, the Kansas City District of the Corps of Engineers requested that the Public Health Service determine the present and prospective water needs for municipal and industrial uses and for water quality control in the Little Blue River Basin in Missouri.

This study has been made in accordance with the Memorandum of Agreement dated November 4, 1958, between the Department of the Army and the Department of Health, Education and Welfare, relative to the Water Supply Act, as amended (43 USC 390b) and the Federal Water Pollution Control Act, as amended (33 USC 466 et seq).

Purpose and Scope

The purpose of this study is to determine the need for and value of storage for municipal and industrial water supply and water quality control in the Little Blue River Basin. The Little Blue River Basin drains an area of 225 square miles in Jackson and Cass Counties located in west-central Missouri. The study covers a 100-year period, 1970 to 2070, as requested by the Corps of Engineers.

Acknowledgments

The cooperation and assistance of many persons and agencies are gratefully acknowledged. Special appreciation is expressed to the following:

Corps of Engineers, Kansas City District, Kansas City, Missouri.

Missouri Water Pollution Board, Jefferson City, Missouri.

Missouri Division of Health, Jefferson City, Missouri.

Missouri Water Resources Board, Jefferson City, Missouri.

Missouri State Geological Survey and Water Resources, Rolla, Missouri.

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Summary of Findings

1. The Corps of Engineers is making a study of the feasibility of constructing multipurpose reservoirs for flood control, municipal and industrial water supply, recreation, and water quality control in the Little Blue River Basin in Missouri.

2. The study area selected by the Corps of Engineers is the 225 square mile Little Blue River Basin located in northwestern Missouri. Most of the basin is in Jackson County, with a small area in Cass County.

3. The 1960 population of Jackson County, Missouri, was 622,732. It is a part of the Kansas City Standard Metropolitan Statistical Area. The population in the Little Blue River Basin is approximately 115,000.

4. The municipal and industrial water supply needs of the Little Blue River Basin are served mainly from the Missouri River through the Kansas City, Missouri Water Department and from the Missouri Water Company, Independence, Missouri. The Lake City Army Ammunition Plant and Belton have well supplies.

5. Average daily municipal and industrial water use in Kansas City, Missouri, in 1963 was 88 million gallons per day (mgd) to supply 650,000 people, approximately 135 gallons per capita per day (gpcd). Average daily municipal and industrial water use in Independence, Missouri in 1963 was 8.2 mgd to supply 102,000 people, or approximately 80 gpcd.

6. The total wastes collected in the Little Blue River Basin amount to approximately 119,000 population equivalents (P.E.). After treatment approximately 16,000 P.E.'s are discharged into the Little Blue River and its tributaries.

Conclusions

1. The population of the Little Blue River Basin is expected to increase from a present population of approximately 115,000 to 300,000 by 2020, and 700,000 by 2070.

2. Based on economic and demographic projections, the municipal and industrial water supply needs in the Little Blue River Basin are expected to increase to 45 mgd by 2020 and to 140 mgd by 2070.

3. The municipal and industrial water supply needs of the Little Blue River Basin in Missouri will be served mainly by the Kansas City, Missouri Water Department and the Independence Water Company.

4. While storage in the proposed projects would supply a portion of the anticipated area water supply need, studies indicate that the amounts of water available are too small to be economically utilized as a prime source of supply. Therefore, no value has been assigned for provision of storage in the proposed projects for municipal or industrial water supply.

5. In accordance with the objective of the Missouri Water Pollution Board, wastes from Little Blue River Basin will be collected for treatment and the treated wastes discharged to the Missouri River. Local areas are expected to discharge treated wastes to the Little Blue River on an interim basis before construction of interceptors is completed.

6. Proposed streamflow regulation for water quality control would enhance the recreational and esthetic enjoyment of the Little Blue River through parks and extensive residential areas, improving approximately 40 miles of stream for recreational uses. The esthetic

values of the stream stemming from clean surface waters, a satisfactory public health environment and preservation of property values in areas of Lee's Summit, Raytown, Kansas City, Blue Springs and Independence contiguous to the stream will thereby be enhanced.

7. An annual draft on storage of approximately 5,800 acre-feet for water quality control will be needed by 2070. The year of first need is 1970. The value of annual benefits is based on the most likely alternative which is a pipeline and pumping facilities to deliver water from the Missouri River. The annual benefit is $255,000, which is based on a capital cost of $6,088,500 amortized over a 100 year period at a rate of 3 1/8 percent. This value includes operation, maintenance and power costs of $55,000 annually.

8. These conclusions are based on the best data available but are subject to revision as field data from the Missouri-Souris-Red River Basins Comprehensive Water Pollution Control Project become available.

III PROJECT DESCRIPTION

Location

The proposed projects are located on the Little Blue River and its tributaries in Jackson County, Missouri, as shown on the location map. See Figure I, located at the back of the report.

Pertinent Data

Three reservoir sites controlling runoff from approximately 90 square miles in the basin, are under consideration by the Corps of Engineers. Under present conditions the water that would enter the Longview reservoir would be polluted with sewage plant effluents and urban runoff. Table No. III-1 shows the approximate locations and drainage areas at these damsites.

The Longview reservoir, located in the southern part of the basin, is proposed for construction at this time.

Table No. III-I
Reservoir Sites
Little Blue River Basin (Missouri)

Reservoir	Stream	Drainage Area Square Miles
Longview	Little Blue River	50
East Fork	East Fork Little Blue River	34
Lake City	Prairie Fire Creek	7.4

IV. STUDY AREA DESCRIPTION

Location and Boundaries

The Little Blue River Basin is immediately east of the Blue River Basin and south of the Missouri River in west-central Missouri near Kansas City, Missouri.

The Little Blue River rises in Cass County, Missouri, southeast of Grandview, and flows in a northeasterly direction for about 40 miles, discharging to the Missouri River northeast of Independence, Missouri. The basin is about 33 miles long with a maximum width of about 12 miles and has a drainage area of 225 square miles. See Figure-1 located at the back of the report.

Geography and Topography

Land elevations in the Little Blue River Basin range from over 1,050 feet in the headwaters near the Jackson-Cass County line to approximately 680 feet above mean sea level at the junction of the Little Blue River with the Missouri River.

The topography is gently rolling and the main stream and the chief tributaries meander through flat bottom lands.

Climate

The U. S. Weather Bureau has maintained weather data records for the Kansas City area since July 1888. The highest temperature of record was 113° F in August 1936 and the lowest temperature of -22° F in February 1899. The mean annual temperature is 55° F; the mean daily maximum is 65° F; and the mean daily minimum is 46° F. The normal frost free growing season is approximately 180 days.

The annual rainfall averages about 35 inches but has varied between extremes of 21.5 and 50.2 inches.4/ The precipitation is distributed through the seasons as follows: spring - 29 percent; summer - 34 percent; fall - 25 percent; and winter - 12 percent.

Principal Communities and Industries

The principal communities in the study area are: Independence, Kansas City and Raytown with 1960 populations of 62,328, 475,539 and 17,083, respectively.

V. WATER RESOURCES OF THE STUDY AREA

Surface Water

Flows in the Little Blue River and its tributaries are extremely variable. The basin is subject to periods of high runoff from rather frequent severe thunderstorms and periods of no flow. A gaging station is located 3 miles southwest of Lake City at river mile 10.5 (drainage area 184 square miles).

Records for this station indicate the mean flow for 15 years of record is 101 cfs. The river reached its maximum flood discharge of record (9,460 cfs) September 14, 1961. During the period of record (1948 to 1963), periods of no flow were reported from August 6 to September 3 and September 11 to September 30, 1953.

The low monthly mean discharge in cfs for each of the water years 1949 to 1963 are as follows: 19.7, 24.6, 6.10, 8.84, 0.02, 0.13, 3.96, 0.36, 0.22, 32.8, 11.1, 5.10, 22.3, 14.8 and 10.6.

There are no long term chemical quality records of surface waters of this River Basin. Table V-1 shows the results of two water quality samples collected at the stream gaging station site by the U. S. Geological Survey.

Table V-1

Mineral Quality of the Little Blue River[4/]
Little Blue River Basin (Missouri)

Constituent	Sampling Date 5/10/52	7/11/52
Discharge, cfs	121	16.2
Sulfate (SO_4), mg/l	50	38
Chloride (Cl), mg/l	8.0	8.0
Nitrate (NO_3), mg/l	5.9	4.9
Total Dissolved Solids, mg/l	318	310
Total Hardness (as $CaCO_3$), mg/l	226	202

According to PHS Standards, chlorides, sulfates, total dissolved solids, and nitrates in drinking water should not be in excess of 250, 250, 500 and 45 mg/l respectively if a more suitable supply is available.

Ground Water

The alluvial deposits in Little Blue River Valley near Lake City yield moderately large ground water supplies. Lake City is a small community near the Lake City Ordnance Plant. There are indications that the Little Blue River once flowed eastward past Lake City and Buckner. During the process of changing its course, a comparatively deep channel was cut and later filled in the vicinity of Lake City. Ground water levels in this vicinity range from about 20 to 25 feet below the land surface. In June 1942, seven wells at the Lake City Ordnance Plant had an average yield of 360 gpm with an average drawdown of 6.7 feet.4/

The water from the Little Blue River alluvium is generally softer and contains lesser amounts of sulfate ion than that of the Missouri River alluvium. Alluvial deposits of glacial origin in the Lake City Valley yield the best quality water found in unconsolidated material in the Kansas City area.

In the Independence, Missouri area of the Missouri River flood plain, an alluvial deposit, approximately 3 miles wide, averaging about 95 feet in thickness extends for about 15 miles. The lower part of the alluvium is permeable and furnishes large supplies of water. The water table is generally less than 25 feet below the surface, and in much of the area the water bearing materials have a saturated thickness of at least 80 feet.

The above alluvial deposits are an important ground water resource for industrial and municipal use in the Little Blue River Basin.

VI. ECONOMY

An assessment of future municipal and industrial and quality control water requirement in the Little Blue River Basin involves an appraisal of the area's future population and industrial growth potential. The increasing regional and national demand for goods and services affords an opportunity for attracting new industries and expanding existing ones.

Past and Present

The Little Blue River Basin, located in Cass and Jackson Counties, is part of the Kansas City Standard Metropolitan Statistical Area (SMSA). The U. S. Census Bureau, and other economic data is generally presented by counties. Therefore, for this report, only population will be presented and projected.

In 1960, the basin had a population of about 115,000. The municipalities partly or wholly located in the basin and their 1960 population are shown in Table VI-1.

Table VI-1 [1/]

Municipalities Partly or Wholly in Basin
Little Blue River Basin (Missouri)

Municipality	1960 Population
Belton	4,897
Blue Springs	2,555
Grandview	6,027
Independence	62,328
Kansas City	475,539
Lake City (Army Ammunition Plant)	750
Lee's Summit	8,267
Raytown	17,083
Unity Village	153
Richards-Gebaur Air Force Base	3,900

Future

The proximity to Kansas City should have the most significant effect on the future growth of the Little Blue River Basin. Continual industrial and commercial expansion in Kansas City should be reflected in residential, commercial, and some industrial increases in the Little Blue River Basin.

Recently the City Planning Department completed population studies 1964-1990. Using this report as a basis, population in the Little Blue River Basin is expected to increase to about 300,000 in 2020 and 700,000 by 2070. As part of the Kansas City SMSA, this entire population should be considered urban.[2/]

VII. WATER REQUIREMENTS - MUNICIPAL AND INDUSTRIAL

Past and Present Water Use

The Kansas City Water Department, Kansas City, Missouri and the Missouri Water Company, Independence, Missouri supply most of the municipal and industrial water used in the Little Blue River Basin. In 1963, the Kansas City Water Department provided a total of 88 mgd to a population of 650,000 and the Independence Water Company provided 8.2 mgd to a population of 102,000. Wells at the Lake City Ordnance Plant provide for an average use of 1.5 mgd. An average of 0.3 mgd is obtained from wells to serve approximately 6,000 persons in Belton.

Future

The increase in municipal and industrial water supply requirements in the basin during the study period is based on the anticipated population growth, commercialization, and increased per capita use occasioned by a higher standard of living and the continued development of water using devices for the home. The study area is expected to have a steady, light industrial and commercial growth, but no significant expansion of heavy water using industry. It is expected that Kansas City, Missouri and the Missouri Water Company will continue to serve most of the projected water demands in the Little Blue River Basin. Table VII-1 shows the expected water use.

Table VII-1

Municipal and Industrial Water Needs
Little Blue River Basin (Missouri)

Year	Unit Water Use gpcd	Population	Water Use mgd
1965	90*	115,000*	10*
2020	150	300,000	45
2070	200	700,000	140

*Estimated

Water storage in the proposed reservoirs could supply a portion of the area water supply needs, but studies indicate that water from impoundments in the basin could not be economically utilized. Surface water in the basin is polluted by sewage plant effluents and urban runoff which makes it undesirable as a source of water for municipal and industrial uses. The small yields and variation of water quality, as compared to ground water make it impractical to utilize water from the proposed reservoirs. The higher capital and operation and maintenance unit costs of these small water supplies would result in higher water costs than the present sources.

Kansas City plans to increase its water treatment capacity on the Missouri River and is also interested in obtaining an additional major source of supply from the large planned reservoir immediately south of the area in the Osage River Basin. The Missouri Water Company, Independence, can develop more capacity in the Missouri River alluvium. The smaller communities will continue to depend on Independence and Kansas City to supply their water demands. There is, therefore, no need for municipal and industrial water supply storage in the Little Blue River Basin.

VIII. WATER QUALITY CONTROL

Municipal, Industrial and Agricultural Pollution

The water quality of the Little Blue River and its tributaries is seriously affected by (1) organic wastes from natural runoff, (2) stormwater overflow from sewers, and (3) municipal and industrial waste treatment plant effluents. Several communities and housing projects developed in recent years have outgrown their sewage collection systems and sewage treatment plants. The resulting low DO concentrations, extensive attached aquatic growths, and odors have caused considerable pressure for immediate water quality improvement.[12/] With the anticipated population growth and consequent increased waste discharges, the Missouri Water Pollution Board has recommended that all wastes be intercepted as the area develops and piped downstream for treatment prior to discharge into the Missouri River.

Data furnished by the Missouri Water Pollution Board on sources of pollution, including treatment provided, are presented in Exhibit 3 of the appendix. The estimated present population equivalent (P.E.) of the raw wastes before treatment is 118,940 P.E. Waste discharge points are shown schematically on Figure VIII-1.

The present sewage treatment facilities, generally waste stabilization ponds, are expected to be used as an interim measure until it is economically feasible to construct a central sewage collection and treatment system for the entire drainage area.

Water Quality Criteria

The water quality control criteria used in this report are based

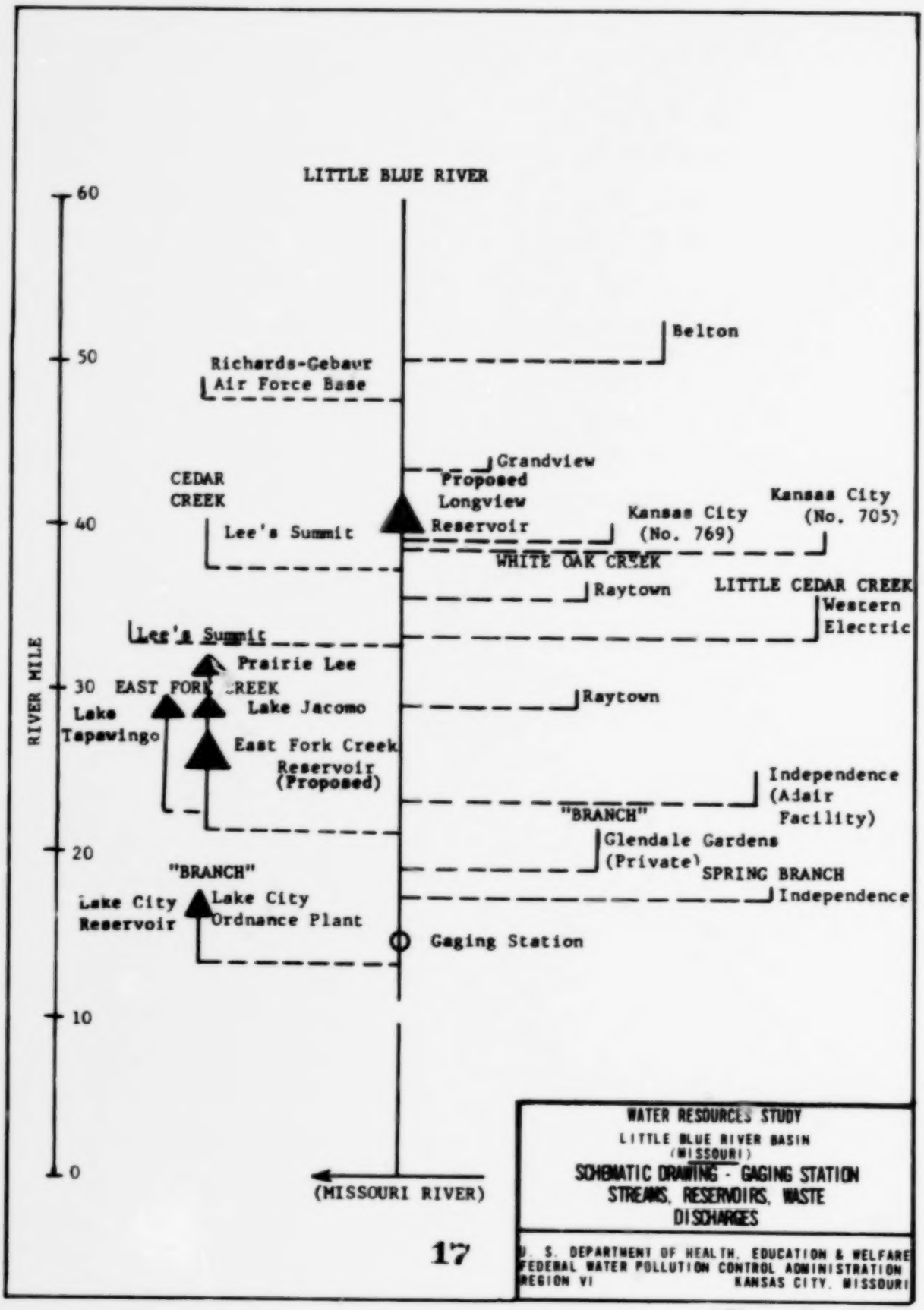

Figure No. VIII-1

on the principal uses to which the streams in the basin are expected to be put, namely fishing and recreation.

Concentrations of at least 3-5 mg/l of dissolved oxygen are necessary to maintain native fish and other aquatic life associated with a healthy stream environment. Maintenance of some dissolved oxygen is also essential to prevent nuisance conditions.

Two lakes, Jacomo and Prairie Lee, in Lee's Summit are used for fishing and boating and indicate the local interest in water sports recreation in the area. There has been considerable interest in developing more recreational lakes to serve the Kansas City metropolitan area. This indicates the importance of maintaining water quality to protect the health of persons participating in water sports and increase the esthetic enjoyment of all people in the area.

Since available data indicate that the mineral quality of the Little Blue River is satisfactory, quality control needs are based on the effect of organic materials on the stream. The effect of organic waste discharge and the hydraulic characteristics of individual streams is reflected in the dissolved oxygen level. A dissolved oxygen objective of at least 5 mg/l has been selected in this study for the Little Blue River to maintain fish and aquatic life and to maintain and enhance present and anticipated recreational use of the stream. Maintenance of this objective at the minimum point will assure still higher dissolved oxygen concentrations in most cases. The Missouri Conservation Commission reports that the Little Blue River is grossly polluted and has no value as a fishing stream and only the most tolerant of fish species could possibly live in the water.

Flow Regulation

The Federal Water Pollution Control Act, as amended (33 USC 466 et seq), provides that consideration must be given in the survey or planning of a reservoir by a Federal Agency to the inclusion of storage for regulation of streamflow for the purpose of controlling water quality. The law expressly states that such storage and water releases shall not be provided as a substitute for adequate treatment or other methods of controlling wastes at their source. For domestic wastes, it is considered possible to obtain 85 to 90 percent removal of BOD with well operated secondary waste treatment of adequate capacity. Stormwater runoff from urban areas has also been found to contain organic materials having a BOD totalling up to 8 percent or more of the amount discharged from a residential area on an average annual basis.

The interim discharge of wastes, even when treated to the maximum extent technically and economically feasible, will cause an unsatisfactory condition in waters whose waste assimilation capacity is exceeded.

It is expected that wastes will be intercepted and removed from the stream soon after 1970. The discharge of wastes upstream of the reservoir should be discontinued before the proposed Longview Dam is constructed. After the interceptor sewer is completed, it will be desirable to maintain minimum streamflows below the proposed reservoir to prevent adverse effects of urban runoff. Based upon the expected effects of urban runoff on the DO in the stream, an average release of 8 cfs from the reservoir is desirable to improve the water quality in approximately 40 miles of stream.

Considering the need for water quality control, provision of storage

in 1970 to assure that streamflows are met 90 percent of the time is considered desirable. Actual releases should be based on observation of water quality and quantity, taking into account temperature, wastes actually reaching the stream, the quantity of water available in storage at the time, and anticipated rainfall. The draft on storage* needed to provide 8 cfs and to supplement the natural flow from 1970 through 2070 has been estimated to be 5,800 acre-feet per year.

*Annual draft on storage is defined as the sum of the incremental excesses of needed releases over inflows during a climatic year (April-March).

IX. BENEFITS

Water Supply - Municipal and Industrial

Several alternatives were considered as sources of water to supply the projected municipal and industrial water supply needs in the Little Blue River Basin study area in Missouri.

Ground water in the basin is limited and is not considered an adequate source of water for municipal and industrial water supply in the Little Blue River Basin.

The total yield that can reasonably be anticipated from the proposed reservoirs is inadequate to supply the projected demand of the study area. The water companies in Kansas City and Independence supply most of the needs in the area, and are expected to continue to serve most of the municipal and industrial water demands in the Little Blue River Basin.

It was concluded that storage in the proposed reservoirs would have too small a yield to warrant development.

Water Quality Control

The Little Blue River and its tributaries flow through intensively developed residential and commercial areas. Improvement of the land adjacent to the Little Blue River as a parkway has been considered in the development of the area. According to the Missouri Conservation Commission, the Little Blue River has been observed to be polluted for extended periods of time, especially in the summer season. Increased discharge of wastes to the Little Blue River, even with adequate treatment, can result in nuisance conditions for extended periods of time as has been observed in the Blue River (Kansas and Missouri) and some of its branches.

Maintenance of flow in the river through streamflow regulation could reduce or eliminate the occurrence of nuisance conditions. Provision of sufficient storage to maintain the selected quality objective of 5 mg/l dissolved oxygen would make approximately 30 miles of river for recreational use available.

Flow regulation should be considered an integral part of the water quality control program of the area. Removal of a greater proportion of the waste from the area would reduce, but not eliminate, the need for storage to regulate flow. Future complete removal of collectable wastes from the area would reduce the amount of streamflow required to maintain quality.

The major water sports activities will be in the reservoir, but streamflow regulation will improve the downstream water quality. The esthetic values of the Little Blue River will be enhanced for people using the proposed parkway and adjacent picnic and recreational facilities.

The value of the benefits of maintaining the dissolved oxygen objective of 5 mg/l is not directly measurable and is generally evaluated in terms of the most economical alternative that would be used in the absence of the multiple purpose project(s) to accomplish the same purpose. Consideration of the drainage area involved indicates that construction of a reservoir to provide the entire draft on storage needed would be impractical, and that the extension of the concept of diversion of wastes from the area, as is recommended by the Missouri Water Pollution Board, must be considered a part of an adequate waste control program. The Missouri Water Pollution Board does not feel that the water quality of the Little Blue can

appreciably be improved by flow regulation as long as all treated and untreated waste continues to be discharged to the Little Blue River from the headwaters to the mouth. The future objective for water quality control of the Little Blue should be the removal of all waste discharges and transport wastes by closed pipe to some point downstream near the Missouri River.

Provision of storage to maintain the dissolved oxygen objective of 5 mg/l is generally considered worth the cost of the most likely alternative. It should be worth at least an equal expenditure to maintain quality in the built-up areas of the Little Blue River Basin after diversion of all collectable wastes has been provided. There is not enough drainage area above the proposed reservoirs to provide the streamflow regulation required for the assimilation of adequately treated wastes.

Due to the importance of maintaining as good a quality of water as possible during the interim period, while an area collection system is being developed, and as urban runoff becomes an increasingly important waste source in the built-up area, it is felt that provision for streamflow regulation that is available will have considerable benefits.

Facilities to assure an annual draft on storage of 5,800 acre-feet from a single-purpose reservoir at the Longview site would cost $514,000 per year, including operation and maintenance. The construction cost of $15,200,000 of a single-purpose reservoir is amortized over a hundred years at 3 1/8 percent. The annual operation and maintenance is $15,000.

However, a less costly alternative is considered to be a pipeline and pumping facilities to deliver water from the Missouri River to the vicinity of the Longview site. This 26 mile pipeline with 4 pumping stations (because of the high static head and head loss) would cost $255,000 annually including power costs, operation and maintenance. The capital costs would amount to $6,088,500 which include engineering, design, supervision, administration and contingencies is amortized over a hundred year period at 3 1/8 percent. Power costs, operation and maintenance is $55,000 annually.

The dollar value of the benefits was not discounted since the year of first need is the beginning of the study period, 1970. These benefits will accrue to residents living in the vicinity of the Little Blue River. Proposed streamflow regulation for water quality control would enhance the recreational and esthetic enjoyment of the Little Blue River through parks and extensive residential areas, improving approximately 40 miles of stream for recreational uses. The esthetic values of the stream stemming from clean surface waters, a satisfactory health water environment and preservation of property values in areas of Lee's Summit, Raytown, Kansas City, Blue Springs and Independence contiguous to the stream will thereby be assured. Storage in the reservoir is considered to be needed immediately for use in the orderly development of water quality control measures in the basin. The benefits are considered widespread and general in nature.

X. BIBLIOGRAPHY

X. BIBLIOGRAPHY

1. Bureau of the Census, U. S. Census of Population: 1960, Volume I, "Number of Inhabitants," Government Printing Office, Washington: 1961.

2. City Planning Department, Population - Kansas City Studies 1964-1990, Community Renewal Report, Kansas City, Missouri 1964.

3. Geological Survey, 1963, Surface Water Records of Missouri, Surface Water Branch, Rolla, Missouri, 1963.

4. Geological Survey, Water Resources of the Kansas City Area, Missouri and Kansas, By V. C. Fishel, J. K. Searcy, and F. H. Rainwater, Government Printing Office, Washington: 1963. (Geological Survey Circular 273)

5. Division of Health, Census of Public Water Supplies in Missouri, State Printing Office, Jefferson City, Missouri: 1962.

6. Public Health Service, Urban Land Runoff as a Factor in Stream Pollution, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, October 1963.

7. Public Health Service, Municipal Water Facilities Inventory as of January 1, 1963, Region VI, Government Printing Office, Washington: 1964.

8. Public Health Service, 1962 Inventory, Municipal Waste Facilities, A cooperative State-Federal Report, Region VI, Government Printing Office, Washington: 1963.

9. Public Health Service, Lower Missouri River Basin Water Pollution Investigation October 1952, Water Pollution Series No. 47.

10. Unpublished data, Missouri Water Pollution Board, Jefferson City, Missouri.

11. Burns and McDonnell Engineering Company, Report on Feasibility of Little Blue River as a Water Supply Source, Kansas City, Missouri, 1964.

12. Unpublished correspondence, Missouri Conservation Commission, Jefferson City, Missouri.

APPENDIX

Exhibit No. 1

Municipal Water Supplies
Little Blue River Basin (Missouri)

Location	Population Served 1960	Population Served 1963	Source of Supply	Water Treatment	Maximum Dependable Draft (mgd)	Average Plant Output (mgd)	Estimated GPCD
Belton	4,897	6,000	1 Well	Chlorination	0.400	0.300	50
Blue Springs	2,555	3,200	Lake City Ordnance Plant	---	---	---	--
Grandview	6,027	6,025	Kansas City	---	---	---	--
Grandview Air Force Base							
Independence	62,328	102,000	7 Wells	Iron Removal, Softening Chlorination	---	8.200	80
Jackson County							
Water Dist. #1	---	9,400	Kansas City	---	---	---	--
Water Dist. #2	---	14,500	Kansas City	---	---	---	--
Water Dist. #8	---	1,750	Independence	---	---	---	--
Kansas City	475,539	650,000	Missouri River	---	---	88.0	135
Lake City Ordnance Plant							
Lake Tapawingo	900	1,200	Independence	---	---	---	--
Lee's Summit	8,267	11,500	Kansas City	---	---	---	--
Raytown	17,083	18,000	Kansas City	---	---	---	--

Exhibit No. 1

Exhibit No. 2

Chemical Analyses of Treated Water
Little Blue River Basin (Missouri)
(Results in Milligrams per Liter, mg/l)

Location	Dissolved Solids	Chlorides (Cl)	Sulfates (SO_4)	Hardness (as $CaCO_3$)	Iron (Fe)	Remarks
Belton	364	30	156	86	0.06	1 Well
Blue Springs	175	12	50	98	0.2	Lake City Ordnance Plant
Independence	225	25	84	90	0.04	7 Wells
Kansas City	258	22	125	85	0.0	Missouri River
Lake City Ordnance Plant	175	12	50	98	0.2	Wells

Exhibit No. 3

Basic Data on Sources of Pollution
Little Blue River Basin (Missouri)

Location	River Miles* Above Mouth	Population 1960	Population 1965 Served	P.E. Before Treatment	Type of Waste	Treatment Provided	P. E. Discharged	Water course
Bradley's Trailer Park (Belton)	50.5		300 E	300 E	Domestic	Secondary (1.52A Lagoon)	30	Little Blue River
Belton's Facility	50.0	4,869	2,500 E	2,500 E	Domestic	Secondary	375E	Little Blue River
Richards-Gebaur Air Force Base	47.5-1	3,900	5,000 E	5,000	Domestic	Secondary	800E	Branch to Little Blue River
Grandview	43.5	6,027		13,000	Domestic	Secondary	1,300	Little Blue River
K. C. Facility								
No. 769	39-1.5		320	320	Domestic	Secondary	32	Branch to Little Blue R.
No. 705	38.5		10,000	10,000	Domestic	Secondary	1,000	Little Blue River
Lee's Summit Plant	37-3.0	8,267	5,000	5,500	Domestic	Secondary	825	Cedar Creek to Little Blue River
Westvale (Private) Lee's Summit	37-1.5-0.5	8,267	240	240	Domestic	Secondary	12	Cedar Creek to Little Blue River
Unity Gardens Private - Lee's Summit	36-1.5		130	130	Domestic	Secondary	13	Branch to Little Blue River
Raytown South Wood Plant	35.5-1.5	17,083	9,000	9,000	Domestic	Secondary	1,350	White Oak Creek to Little Blue River
Western Electric Lee's Summit	33-4	(Sanitary wastes go to Lee's Summit)		(200,000 gpd)	Industrial	(Neutralization & Holding Pond & Precipitation)		Little Cedar Creek to Little Blue River
Jackson County Home for Aged	33-1.5	1,200 E	1,200 E	1,200 E	Domestic	Secondary	240E	Branch to Cedar Creek to Little Blue River

Exhibit No.3 (continued)

Basic Data on Sources of Pollution
Little Blue River Basin (Missouri)

Location	River Miles* Above Mouth	Population 1960	Population 1965 Served	P.E. Before Treatment	Type of Waste	Treatment Provided	P. E. Discharged	Water course
Lee's Summit	32.5	8,267	5,000	8,000	Domestic	Secondary	800	Little Blue River
Raytown	29	17,083	21,000	21,000	Domestic	Secondary	2,100	Little Blue River
Adair Facility Independence	23-2	62,328	9,300	9,300	Domestic	Secondary	1,400	Branch to Little Blue River
Lake Tapawingo	21-1.5 -1.5	750	750	750	Domestic	Treatment Proposed	750	Branch to E. Frk. L. Blue R. to L. Blue R.
Glendale Gardens Subdivision - Private	19-2.5		2,500 E	2,500 E	Domestic	8.36A Secondary	250	Branch to Little Blue River
Walnut Gardens Subdivision - Private	19-0.5-1		400 E	400 E	Domestic	1.25A Secondary	40	Branch to Branch to Little Blue River
Independence	17-1	62,328	28,700	28,700	Domestic	Secondary	5,000	Spring Branch to Little Blue River
Lake City Ordnance (U.S.Govt)	13-1		1,000 E	1,000	Domestic	Secondary	100	Branch to Little Blue River
"	13-2			200,000 gpd 7:00am to 6:00pm	Industrial	Neutralization & Precipitation		"
"	13-3	No plating being done.			Cyanide-Industrial	Oxidation & Precipitation	Not in use	"
McCune Home for Boys	10.5-0.5	100	100	100	Domestic	Secondary	15	Creek to Little Blue River
			TOTALS	118,940			16,432	

*Mouth of Little Blue River is at Missouri River Mile 339.5 (From 1961 Missouri River Navigation Map)

Exhibit No. 3 (2)

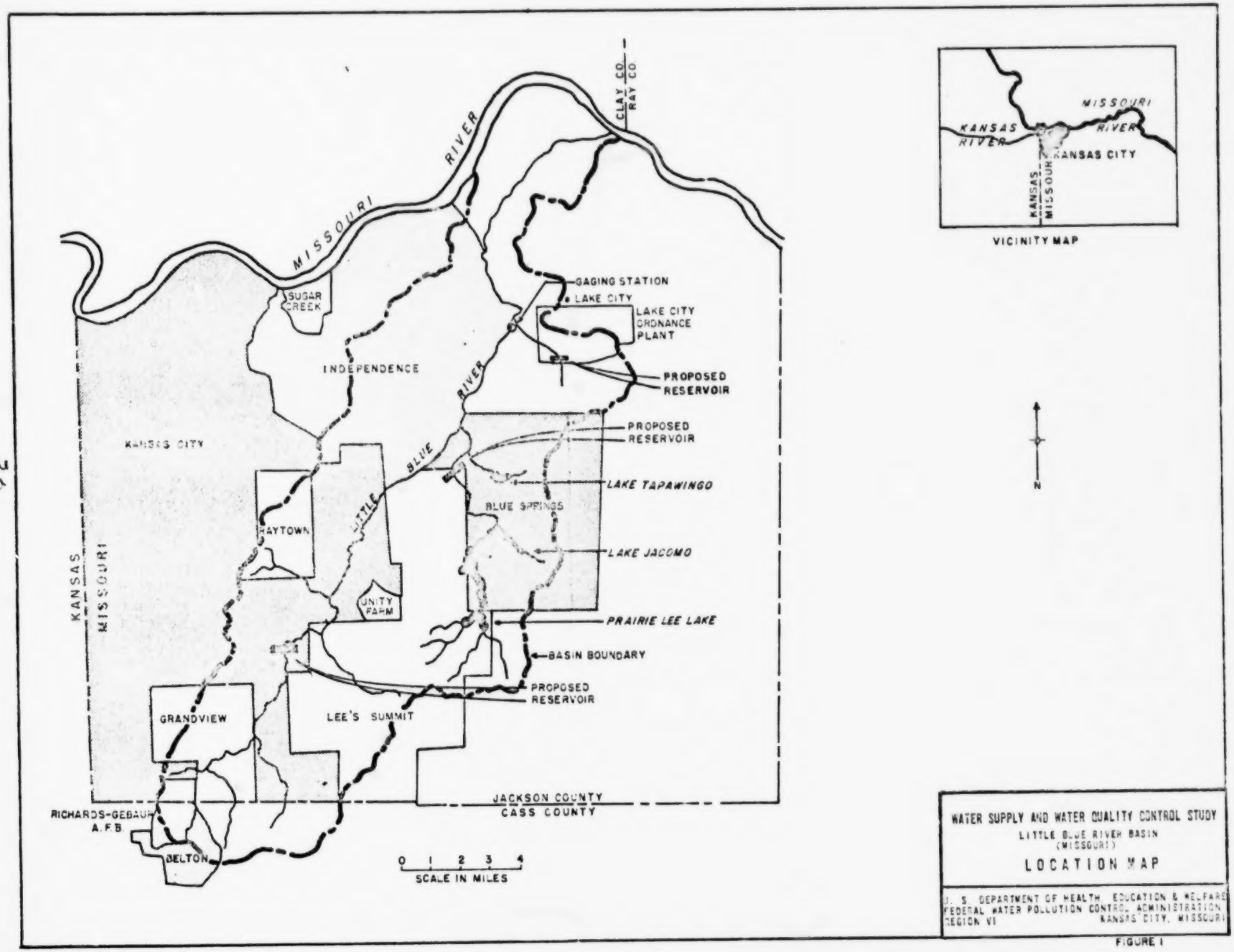

FIGURE 1

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